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A critical review of digital storyline-enhanced learning

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Abstract Storyline is one of the major motivators that lead people to play video games. However, little empirical evidence exists on the instructional effectiveness of integrating a storyline into digital learning materials. This systematic literature review presents current empirical findings on the effects of a storyline game design element for human learning and performance that were analyzed using a multidimensional approach for classifying storyline outcomes and impacts. Specifically, it addresses two key questions: (a) What types of storyline were empirically examined? and (b) What are the unique affordances of digital storyline-enhanced learning? Only eleven studies that assessed the relative effectiveness of digital story-based interventions as compared to a non-story-based method were found. These findings present mixed results for storyline-related instructional effectiveness and suggest directions for future investigations and also practical guidance for designing effective story-based digital learning environments.

Keywords Storyline · Digital narrative · Computer games · Game design · Engagement · Learning outcomes

Introduction

The potential for bringing motivational and engaging qualities of stories to digital learning has been recognized by researchers, educators, and the military since the early 1990s (Iuppa and Borst 2007). Storylines further engage meaningful learning, make learning more memorable, and can present complex real world situations to help learners more easily understand and then apply content knowledge. One major advantage of enhancing learning materials with storylines is increased student interest (Lee and Chen 2009).

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The U.S. military was among the first to acknowledge the benefits of digital storyline-enhanced learning for human training. In 1995, the Department of Defense, together with the National Science Foundation, organized a conference on computer games and military strategic planning that led to a close collaboration between the Television Group at Paramount Pictures and the Department of Defense. As a result, large scale, storyline-enhanced simulations were designed for military training. They focused primarily on tactical decision-making under stress as well as interpersonal and leadership skills.

Digital storyline-enhanced learning materials have also been employed in K-12 and higher education settings to teach various academic skills, including mathematics (e.g., Bittick and Chung 2011; Parker and Lepper 1992), statistics (Novak 2014a; Novak et al. 2014), and science (Spires et al. 2010). In addition, digital storylines have been used in more informal learning settings like museums and national parks (Sung et al. 2008). Technological advances have further increased the availability of educational authoring tools that prompt educators to consider digital, story-based learning materials as a viable instructional medium. Game authoring tools allow for creating game-like learning environments, where educators can gamify instructional content by embedding game design elements like reward, storyline, or completion (Marchiori et al. 2012). However, the effects of such embedding have not been extensively studied to date and particularly for how a storyline game design element can affect learning.

This literature review identifies the empirical studies that have examined the effects of a storyline game design element on human performance to answer two key questions: (a) What types of storylines have been empirically examined? (b) What are the unique affordances and benefits of digital storyline-enhanced learning? The focus is on learning outcomes and general learning benefits, such as retention, self-regulation, motivation, and engagement, which can facilitate acquisition of other learning outcomes. A further question is whether a recently proposed Connolly's et al. (2012) classification of outcomes associated with game-based learning can be applied for analyzing the outcomes of storyline-enhanced learning.

Linking game design elements with learning outcomes and benefits

Several researchers have linked game design elements to specific learning outcomes or benefits to provide the basis for whether or not to consider games as part of an instructional solution, and if so, determine which game design features are most appropriate for instruction. Johnson et al. (2007), for example, suggested 14 gaming characteristics based on a comprehensive literature review that examined challenge, competition, rules, goals, fantasy, changed reality, immediate feedback, interaction, story or representation, engagement or curiosity, role playing, control, tasks, and multimodal presentation. The authors found that (1) gaming characteristics are critical to successful game design in general, and (2) the literature links games (not gaming characteristics) to learning situations in general (but not to any specific instructional objectives or definite desired outcomes).

Wilson et al. (2009) reviewed game attributes and identified 18 game design features believed to impact learning: Adaptation, assessment, challenge, conflict, control, fantasy, interaction (equipment), interaction (interpersonal), interaction (social), language/communication, location, mystery, pieces or players, progress and surprise, representation, rules/goals, safety, and sensory stimuli. The authors analyzed games used in the gathered studies for design features as they related to the desired learning outcomes. However, the vast majority of the reviewed games utilized a mix of multiple game design features, and

thus, it was impossible to determine the instructional benefits of single game design elements. Wilson et al. concluded that more empirical studies are needed to examine which game design features lead to which learning outcomes.

The notion of game design elements affecting learning is equally important to the design of digital learning environments and the theories of learning. Lepper (1985) observed that linking instructional objectives to game design elements can refine learning and teaching theories. Similarly, Garris et al. (2002) stressed the importance of examining the characteristics of instructional games, stating that

> Although most agree that games can be engaging and that games can be instructive, there is little consensus regarding the essential characteristics of instructional games. Implicit in the research literature is the notion that if we pair instructional content with certain game features, we can harness the power of games to engage users and achieve desired instructional goals (p. 441).

More recently, the Federation of American Scientists (2006) emphasized the importance of developing "a sound understanding of which features of games are important for learning and why, and how to best design educational games to deliver positive learning outcomes" (p. 5). The goal of investigating the effects of game design elements on learning is to identify those elements that help achieve desired learning outcomes and/or make learning with computers and mobile technologies both appealing and motivating, and provide practical recommendations for designing effective digital learning environments to achieve those outcomes.

In order to analyze a wide variety of gaming outcomes, I used Connolly's et al. (2012) classification of learning and behavioral outcomes associated with computer games. The authors classified learning and behavioral outcomes from 129 studies that investigated the effects of playing computer games into one of the four categories: (a) knowledge acquisition/content understanding, (b) perceptual and cognitive skills, (c) motor skills, (d) behavior change. This classification proved to be useful in their analysis of gaming studies, but also highlighted some problems. For example, there was an overlap in classifying some knowledge acquisition and cognitive outcomes, as they could fit several categories and their classification depended on the respective educational or cognitive theories. As a result, the authors proposed a refined higher level classification of outcomes that distinguished (a) knowledge acquisition, (b) skills acquisition, (c) affective, motivational, and physiological outcomes, and (d) behavior change outcomes. One of the goals of the present literature review is to determine whether Connolly's et al. (2012) classification of outcomes associated with playing computer games can be used for analyzing the outcomes of storyline-enhanced learning as a form of gamified learning.

The concept of digital storyline

Why use storylines in learning?

The literature on digital storyline is very inconsistent in terms of terminology used to identify a storyline game design element. Researchers used *story, storyline, digital narrative,* and *fantasy* terms to refer to a story embedded in a digital environment (e.g., Malone and Lepper 1987; Prensky 2001). Following Robert Mckee's (2005), a recognized writer and lecturer, remark that narrative and fantasy are considered as types of storyline, the present literature review does not distinguish between different types of storyline, since they all essentially do tell a story.

The use of storylines in educational digital environments has been extensively debated. The proponents usually highlight the motivational values of a storyline (e.g., Lesgold 1982). While opponents have suggested that storylines can distract learners or leave an impression of a "sugarcoated instruction", thus becoming another example of "edutainment" products that do not contribute to effective learning (e.g., Parker and Lepper 1992).

Storyline has been identified as a prominent game design element that motivates continued playing (Malone 1981; Malone and Lepper 1987). Malone (1980) examined intrinsic and extrinsic fantasy as possible factors that may affect the effectiveness of game-based learning. According to Malone and Lepper (1987), intrinsic fantasy fully integrates fantasy context into instructional content. Intrinsic fantasy sustains player engagement by stating clear objectives, providing a variety of paths to complete those objectives, and motivating the player to act.

Emotionally appealing storylines can motivate and engage, leading to increased learning (Habgood et al. 2005). Although, storyline alone is not powerful enough to sustain player motivation and engagement throughout a game (Asgari and Kaufman 2004), it influences a player's decision on whether or not to engage in game play. The storyline hooks attention at the beginning of the game and also draws the player into the game. In this way, storyline activates other gaming characteristics, such as interactivity, competition, control, curiosity, challenge, and feedback (Asgari and Kaufman 2004).

In addition to providing engaging learning experiences, storylines serve as memory aids. Bruner (1991) argued that human memory and experiences are organized as narratives or storylines. Narrative comprehension is an information-generation process that requires making immediate connections with existing knowledge, thus promoting deeper understanding and facilitating the ability to apply the newly acquired knowledge in different contexts. Roger Schank, a noted Artificial Intelligence scientist, suggested that people develop their understanding of the world by forming mental models of it and use stories to describe these internal world pictures (Iuppa and Borst 2007). Researchers argue that using storylines to present instructional content does facilitate information recall, comprehension, and understanding of the materials (Bransford et al. 1990).

Storyline definition

Including a story in a learning environment "evokes mental images of physical or social situations not actually present" (Malone and Lepper 1987, p. 240). More recently, Sid Meier, a developer of *Pirates!, Railroad Tycoon, Covert Action,* and *Civilization* games described the role of storyline in games by comparing digital games with movies:

> We try and put that amount of realism and accuracy into the game. And then make it fun on top of that. In the same way that a movie gives you all the fun and the action sequences and all the important parts of a story and then jumps quickly over the boring things, I think the game has the same responsibility, to bring you to the key decision points and then move you on to the next interesting thing. (Rouse 2005, p. 30).

Sid Meier's description of what constitutes a good digital storyline highlights the mechanics of Hollywood storytelling. Figure 1 shows a diagram of the arc of the story presented to the members of the U.S. military to explain how the structure of Hollywood stories can be used for developing storyline-enhanced simulations.

Based on classical dramatic theory, the arc of the story creates an emotional tension in the reader/spectator as it unfolds (Laurel 1993). This tension can be visualized by a curve presented in Fig. 2.

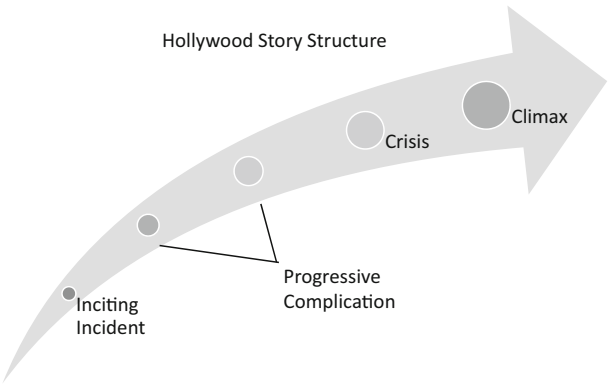

Fig. 1 Slide from Paramount presentation to the U. S. Army explaining the classic Hollywood story structure. Adapted from Iuppa and Borst (2007), p. 43

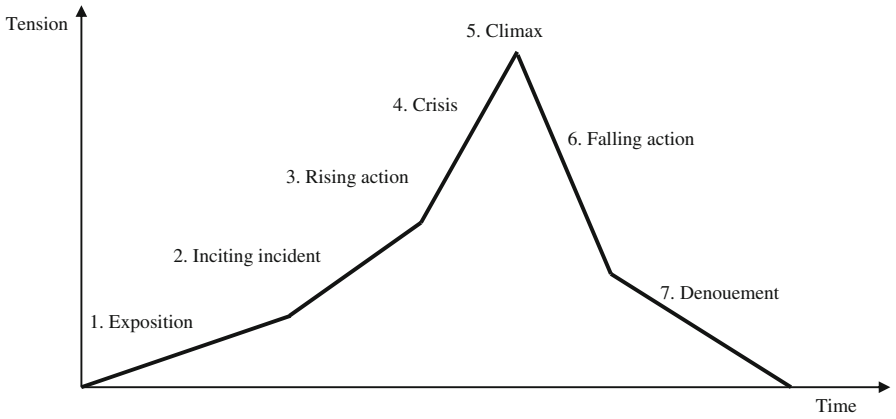

Fig. 2 Phases of a dramatic story according to Laurel (1993). Adapted from Laaksolahti (2008), p. 9

Iuppa and Borst (2007) in their book, *Story and simulations for serious games*, examined various perspectives of noted writers, story theorists, and game developers on what constitutes a good story in video games. They contend that a good digital story provides "the structuring of events so that they make sense and achieve a sense of order and meaning not experienced in the real world…. It is the selection, organization and building up of these events that create the story arc that is at the heart of the Hollywood Story. The concepts of surprise, insight and learning that come at key moments of the story have special meaning for stories used in serious games" (p. 44–45). From the review of these perspectives, it is possible to conclude that a good digital story is much more than a structured set of story events. The key element in the definition of a digital storyline is the relationship between the structured set of story events and an emotional tension created by these events.

Digital storyline design

A major benefit of digital storyline-enhanced learning versus traditional storytelling media like books and movies is the interactivity (Miller 2004). Interactivity substantially changes

the learning experience from a learner passively receiving information by reading, listening, or watching to becoming actively involved with the storyline content. Digital storyline-enhanced learning allows individuals to relate directly to content by exploring, changing, or manipulating actual storyline settings, events, or characters. Certainly, the design of a digital learning environment and a storyline, in particular, is critical for positive learning outcomes and experiences. Rouse (2005) distinguishes between the three contexts used for telling a story in the game world:

1. Out-of-Game: Here storytelling occurs in the game, but not while players actually are involved in the game play. Examples of out-of-game storytelling include text, images, audio, and cut-scenes, during which the player cannot control game characters, but is guided to view short films, images, or text, or whatever works best for that game. Although out-of-game storytelling devices interrupt the interactive experience of a game, they are so prevalent in the gaming world that players now perceive them as an integral part of the experience. This storytelling approach requires a player to follow the story events and drives player actions.
2. In-Game: Different than out-of-game, this type of storytelling happens while players are actually immersed in a game play. It may include interactions with the game environment, such as the settings, game characters, and communication with other players. A story can be communicated through text messages placed in the game world, level settings that suggest the complexity of the game world, and behaviors and dialogue with game characters. In-game storytelling is an integral part of a game, so there is concern in the gaming world that players may miss part of the story. This type of storytelling is probably the most interactive and the most engaging.
3. External Materials: Here storytelling takes place outside of the game, such as with manuals or paraphernalia that accompany the game as a map, symbols, etc. This approach was particularly popular in the 1980s with arcade games and computers with limited disk space. The major drawback is that players almost never have a full understanding of the story, and the gaming experience is thus non-continuous. This type of storytelling is probably the most passive, since it lacks any interactivity component and does not prompt a learner to interact with the story during game play.

This classification of storytelling approaches can be further extended to include environmental stories. Environmental stories arise from 3-D game settings, graphics, or audio elements without any plot or characters (Jenkins 2004). This type of story may require less cognitive resources, since a student does not need to follow a story plot or identify with story characters.

Each of these four storytelling approaches can create different game experiences and cognitive demands that may influence player learning and attitudes toward the game. For example, if a player does not have a good grasp of the story, she/he may feel less engaged or somewhat disoriented. Effective presentation of cut-scenes or videos can increase player interest. The same story telling techniques may hinder learning and/or gaming experience if presented ineffectively.

Goal of the present review

Although the literature on story-based learning often discusses storytelling in the context of video games, story-based instruction does not necessarily imply learning with video games. Many professional organizations like *eLearning Industry* and *The eLearning Guild* offer

numerous resources on story-based instructional strategies focusing on various principles of storytelling in eLearning and storytelling authoring tools. Story-based gamified learning is a developing trend in the field of educational technology and human training and performance that has been highlighted amongst the best eLearning practices for corporate learners as an effective online training strategy (Wroten 2014).

In light of the growing body of literature on story-based gamified learning and an increased interest in using stories to improve various aspects of human performance in K-12, higher education, military, and business and training settings, it was imperative to conduct a critical review of empirical research to examine the storyline learning affordances. The present review explores how digital storylines have been used to promote the various cognitive and motivational aspects of human performance.

Method

Data collection

Considerable literature on digital storyline-enhanced learning, games, and game-like environments that focuses primarily on a storyline was systematically reviewed. Online databases like ScienceDirect, ERIC, Google Scholar, and PsychInfo were searched using the following search terms and keywords: *Games and learning, gaming characteristics, gaming attributes, game design, game design elements, story, storyline, digital narrative,* and *fantasy*. However, most of the studies were found from references.

Inclusion criteria

The goal was to find published and unpublished articles that reported empirical findings on the effects of a digital storyline on human learning and performance. Specifically, the following inclusion criteria were applied:

1. A storyline game design element is defined as either story, storyline, narrative, or fantasy by the author, or inferred by the reader because the game design element presents the "structuring of events so that they make sense and achieve a sense of order and meaning not experienced in the real world" (Iuppa and Borst 2007).
2. The study embedded a storyline game design element into a digital learning environment.
3. The study included empirical evidence in relation to the outcomes and impacts of integrating storyline in digital learning environments.
4. The study reported on research methods (i.e., participants, instructional interventions, instruments, research design, etc.) and those results. Studies that employed quantitative research reported on statistical analysis methods and their results.
5. The search was not limited to a particular publication type, date range, or research method. Both published and unpublished studies (e.g., dissertations, reports) using various research methods (e.g., qualitative, quantitative, or mix methods) were considered.
6. The search was not limited to studies conducted within a particular geographic area.

Over 70 articles, reports, dissertations, books, and conference presentations were initially identified using the search terms. However, only thirteen quantitative studies met the above inclusion criteria. Eleven of the 13 studies employed an experimental or quasi-

experimental research design indicating that the storyline quantitative research was of high rigor and quality. Given this encouraging number of experimental and quasi-experimental investigations, a meta-analysis expert assessed the possibility of conducting a meta-analysis to evaluate the relative effectiveness of story-based interventions as compared to a non-story-based method. Unfortunately, a limited number of quantitative investigations and insufficient statistical data reported in these studies prevented us from taking a meta-analysis approach. Nevertheless, to establish the high rigor in evaluating and summarizing the existing storyline empirical research, only the eleven experimental studies that assessed the relative effectiveness of digital story-based interventions as compared to a non-story-based method were included in the present systematic literature review. The other two studies were excluded because they employed a non-experimental research design and therefore their findings could not be compared with experimental studies that established a cause-and-effect relationship.

Data analysis

Using a qualitative comparative analysis (Onwuegbuzie et al. 2012), the eleven experimental and quasi-experimental studies that met the inclusion criteria were coded to identify storyline properties, study design and methodology dimensions, and intended outcomes.

The present literature review systematically analyzed similarities and differences across the selected studies to make the connections among the previously developed categories used in reviews of the use of digital games in learning (e.g., Boyle et al. 2014; Connolly et al. 2012) and refine and develop the categories further focusing on digital story-based environments. Below are the classification categories that were adapted in the present review.

Classification of storylines

Storylines employed in the selected studies were classified along the following dimensions:

Primary purpose of the storyline-enhanced digital environment

The primary focus of this literature review was on storyline-enhanced learning environments; but, storyline-enhanced entertainment digital environments were included as well.

Curriculum area

When applicable, storylines were categorized into the following curriculum areas: mathematics, science, and society.

Storytelling approach

Storylines were classified into in-game, out-of-game, external, and environmental categories.

Digital environment

Storylines were integrated into various digital environments such as commercial off-the-shelf (COTS) video games and researcher-made learning environments.

Coding of methods

A number of methodological dimensions were coded for each study.

Study design

This dimension included the following research designs: experimental and quasi-experimental design.

Sample

Sample size and participants' age were included.

Between-group comparison

The number of groups and relative effectiveness of a storyline-enhanced intervention were coded.

Classification of storyline effects

To begin the process of classifying storyline effects, I adapted Connolly's et al. (2012) higher level classification of video gaming outcomes that distinguished between (a) knowledge acquisition, (b) skills acquisition, (c) affective, motivational, and physiological outcomes, and (d) behavior change outcomes. However, after reviewing the included studies, it was realized that Connolly's et al. classification needed to be modified to account for the reported storyline outcomes and impacts. Due to a limited number of studies that explored knowledge and skills acquisition, the first two Connolly's et al. (2012) categories were combined together. Since the reported outcomes did not include behavior change, this category was not considered in the present literature review. In addition, the included studies concerned both educational and entertainment settings that clearly distinguished between learning engagement and entertainment immersive qualities of storyline-enhanced environments. Therefore, in addition to Connolly's et al. affective and motivational outcomes category that focused on learner engagement and interest, I included a perceptual and cognitive outcomes category that covered entertainment and cognitive aspects of storyline-enhanced learning. A modified classification of storyline outcomes included (a) knowledge and skills acquisition, (b) affective and motivational outcomes, and (c) perceptual and cognitive outcomes categories. Table 1 presents all reported outcomes and their respective classification into the modified categories.

Table 1 Classification of storyline effects

Knowledge and skills acquisition outcomes (63.64 %)	Affective and motivational outcomes (72.73 %)	Perceptual and cognitive outcomes (30.77 %)
Learning effectiveness (63.64 %)	Motivation/engagement (45.45 %)	Cognitive load (9.09 %)
Retention (9.09 %)	Interest (9.09 %)	Self-presence (9.09 %)
Learning efficiency (18.18 %)	Enjoyment (18.18 %)	Immersion (18.18 %)
	Game evaluation (15.38 %)	
	Storyline evaluation (36.36 %)	

Numbers in parentheses indicate a percentage distribution of the included outcomes

Findings

Storyline dimensions

Purpose of the storyline-enhanced digital environment

Table 2 shows the eleven studies included in this systematic literature review categorized along the storyline, methods, and outcomes dimensions. Of them, eight (73 %) examined the effects of a storyline on learning and motivation in an educational context, and three (27 %) focused on the effects of storyline design on player perceptions and attitudes toward non-educational games. Although the latter three studies (Herrewijn et al. 2013 (1st and 2nd study); Park et al. 2010) did not concern learning, they were included because they informed on how a storyline game design element specifically affected player gaming experiences. Participant age ranged from elementary school students (age $M = 8.81$) to graduate students (age $M = 28$).

The eight studies that examined learning outcomes and benefits associated with a storyline spanned a variety of curriculum areas. Mathematics was the most popular content area that included three studies, followed by society (two studies), science (two studies), and statistics (one study).

The storylines employed in the gathered studies differed in the amount of information and the software used for the development of their individual story-based interventions. Researchers either developed their own learning environments (62.5 %) or used game authoring tools and commercial off-the-shelf (COTS) video games (37.5 %) that allowed for the integration of learning content. For instance, a COTS role-playing video game Neverwinter NightsTM, by Bioware was used to create multi-media interactive fantasy learning environments (e.g., DeRouin-Jessen 2008; Greenwood-Ericksen 2008). Other researchers enhanced the learning content by adding audio-, text-, or interactive multimedia-based narratives (e.g., Bittick and Chung 2011; Novak et al. 2014). For example, Parker and Lepper (1992) developed a series of computer programs for teaching geometric problems by presenting the adventures of detectives, pirates, or astronauts with simple illustrations to create imaginary words. The narratives also differed in the amount of information they presented, e.g., full narratives versus light/partial narratives (Spires et al. 2010).

The literature on innovative technologies included also examples of new mobile devices used in informal learning settings like museums, exhibitions, and national parks. In addition, several story-based technologies were employed in military settings. However, their effects have been rarely examined and were not included in this literature review due to the limited literature that was available.

Storyline outcomes

Knowledge and skills acquisition outcomes

Seven of the eleven selected studies (63.64 %) examined the effects of storyline-enhanced learning on knowledge and skills acquisition. The comparison of story-based and non-story-based interventions in experimental studies revealed mixed results. Six experimental studies with middle school and college students demonstrated that including a storyline either decreased or had no effect on learning (Bittick and Chung 2011; DeRouin-Jessen 2008; Greenwood-Ericksen 2008; Koenig 2008; Novak et al. 2014; Spires et al. 2010). While, an experimental study with elementary students showed positive storyline learning

Table 2 Summary of research investigating effects of storyline on human learning and performance

Study	Curriculum area	Digital environment	Storytelling approach	Participants' age (M)	Sample size	Study design	Storyline outcomes		
							Knowledge and skills acquisition	Affective and motivational outcomes	Perceptual and cognitive outcomes
Malone (1981)	Mathematics	COTS video game	Environmental	Elementary grade students	80	Experimental		*	
Parker and Lepper (1992)	Graphic design and geometry	Researcher—made computer-based instructional programs	Environmental	3rd–4th grade students ($M = 8.81$)	32	Experimental	*	*	
DeRouin-Jessen (2008)	Employment laws	COTS video game	In-game	College students ($M = 19.41$)	169	Experimental	*	*	
Greenwood-Ericksen (2008)	History	COTS video game	In- & out-of-game	College students	92	Experimental	*	*	
Koenig (2008)	Electric circuits	Researcher-made video game	External & in-game	College students ($M = 23$)	126	Experimental	*	*	*
Spires et al. (2010)	Microbiology	Researcher-made narrative-centered learning environment	In- & out-of-game	8th grade students ($M = 13.26$)	151	Experimental	*	*	
Bittick and Chung (2011)	Mathematics	Researcher-made video game	Out-of-game	Grades 6–12	177	Experimental	*	*	
Novak et al. (2014)	Statistics	Researcher-made instructional simulation	In-game	Graduate students ($M = 28$)	64	Experimental	*	*	
Park et al. (2010) (1st study)	Non-educational	COTS video game	External	College students	30	Experimental			*

Table 2 continued

Study	Curriculum area	Digital environment	Storytelling approach	Participants' age (M)	Sample size	Study design	Storyline outcomes		
							Knowledge and skills acquisition	Affective and motivational outcomes	Perceptual and cognitive outcomes
Park et al. (2010) (2nd study)	Non-educational	COTS video game	External	College students	30	Experimental			*
Herrewijn et al. (2013)	Non-educational	COTS video game	External	Adults, 18–37 year old ($M = 22.3$)	62	Experimental			*

*Denotes storyline outcomes explored in each study

outcomes (Parker and Lepper 1992). Nevertheless, an examination of pre-/post-test learning gains associated with a story-based instruction revealed that including a storyline in learning materials did not inhibit student learning and even led to significantly positive results (e.g., Novak 2014a).

Affective and motivational outcomes

Eight of the eleven included studies (73 %) assessed participants' motivation, engagement, enjoyment, attitudes, or interest toward story-based digital environments. Given the fact that the major perceived benefit of story-based instructional strategies is increased learner engagement with and contextualized understanding of taught materials, the majority of the gathered studies have explored both instructional and motivational/affective benefits of a storyline.

Malone's (1981) study that used *Darts*, a game for teaching elementary students fractions, was one of the earliest attempts to examine student preferences for different game design elements. In the game, three balloons are shown on a number line and students need to guess the balloon positions by typing fractions. If a student guesses the balloon position correctly, an arrow pops the balloon on the number line. The author developed eight versions of the game by consecutively stripping down seven game design elements from the original version of Darts to examine their effects on student interest in playing the game: Performance feedback, scoring, constructive feedback, extrinsic fantasy, music, graphic representation, and intrinsic fantasy. Although Malone mentioned the fantasy design element, that element did not include any plot or characters and probably meant a story that came from the game setting. The author distinguished between extrinsic fantasy that weakly related to the skill being taught (an arrow popping a balloon not on the number line, but in another part of the screen) and intrinsic fantasy that was "intimately related" to the skill being taught (an arrow popping a balloon on the number line). Given the large number of independent variables, this study had a very small sample size of 80 students. The participants were randomly assigned to the eight conditions. The results revealed two significant findings. First, adding the extrinsic fantasy of balloons and arrows significantly improved students' "liking Darts." Second, a significant interaction between gender and condition was found. Adding the intrinsic fantasy to the game resulted in significantly lower interest toward the game for girls. According to the author, fantasy plays an important role in creating motivating learning environments. However, if the fantasy does not appeal to the target audience, e.g., females, it may actually decrease student interest in the learning task.

Building upon the prior work of Malone (1981) and Lepper and Malone (1987) that had offered strategies of embedding learning materials in a fantasy context, Parker and Lepper (1992) conducted two studies with third- and fourth-grade students (age $M = 8.81$) to evaluate the effects of fantasy game design element on learning how to draw lines to connect various objects on screen. In the first study, the authors created four computer-based instructional programs that shared identical series of instructional tasks, but differed in the fantasy "embellishments", i.e., environmental stories, to examine the motivational benefits of different fantasy "embellishments." In the basal, no-fantasy, version, children drew abstract lines and geometric shapes. The other three instructional programs presented the same learning content in the context of simple stories, such as a pirate seeking hidden treasures, a detective investigating a crime, and an astronaut looking for new planets. For example, in the no-fantasy version, students were asked to connect a circle to another object on the screen. In the astronaut version, faces replaced the circles, and a student was

guided to go and meet other astronauts. Simple illustrations were used to create the imaginary worlds. The students interacted with each of these versions and rated their interest toward each instructional program. The results indicated that embedding fantasy elements into a learning content had a significant positive effect on the children's motivation. The no-fantasy version had a significantly lower rating than the other three fantasy versions.

After ascertaining the motivational benefits of the fantasy embellishments, Parker and Lepper (1992) conducted a follow-up pre-/post-test experimental study to examine the effects of the fantasy embellishments on immediate and delayed learning of basic graphics commands in Logo and a general understanding of geometric concepts. The results revealed that children in the fantasy conditions outperformed those in the no-fantasy condition for immediate and delayed (2 weeks) learning. Interestingly, on the general geometric concepts test, non-significant differences across the non-fantasy versus fantasy conditions were observed. However, the students in the fantasy conditions performed significantly better on the delayed post-test 2 weeks later. Overall, this study demonstrated that intrinsically motivating fantasy contexts can contribute to increased learning.

After Malone's (1981) and Parker and Lepper's (1992) initial investigations into the instructional and motivational benefits associated with digital fantasy-based learning, no empirical investigations were attempted in this area for almost 16 years. However, the development of more advanced technologies and an increased interest in educational games has revived researchers' interest in digital storyline-enhanced learning. In 2008, three dissertation studies that empirically investigated the relative effectiveness of story-based learning using COTS game engines were published (DeRouin-Jessen 2008; Greenwood-Ericksen 2008; Koenig 2008).

DeRouin-Jessen (2008) manipulated multi-media fantasy and reward game design elements by using a computer-based training program to teach employment laws that govern selection practice content to college students (age $M = 19.41$). This pre-/post-test experimental study systematically investigated the effects of multi-media fantasy (vs. text-based fantasy) and reward (vs. no reward) on the acquisition of declarative and application knowledge and motivation. Five versions of the computer-based training program were created: (1) multi-media fantasy, no reward; (2) multi-media fantasy, reward; (3) text-based fantasy, no reward; (4) text-based fantasy, reward; and (5) a traditional version. The multi-media fantasy version was created using a COTS role-playing video game Neverwinter NightsTM, by Bioware. This game was adapted to allow players to interact with the business owners and employees of different companies in a small town. The game characters communicated with a player via audio, while a player responded by either typing or selecting responses to characters' questions from a menu. The text-based fantasy version was developed using Visual Basic, and the communication between the characters and the players was in text-based format only. The traditional computer-based version was also developed using Visual Basic. This version did not include any storyline, sounds, or graphics, and the information was presented using a bulleted list format. The reward gaming characteristic was facilitated by providing players with points in the format of a salary raise or promotion to a higher position. Contrary to the study hypothesis, the traditional version led to better declarative knowledge outcomes than the multi-media versions. Moreover, adding a storyline or reward game design elements to a training program led to non-significant differences across the conditions in motivation, satisfaction, and application knowledge. In sum, adding a media-based storyline resulted in lower declarative knowledge and had no significant effect on application knowledge, motivation,

and satisfaction. According to the authors, enhancing traditional learning materials with gaming characteristics could distract learners and result in lower performance.

Greenwood-Ericksen (2008) examined the effects of a storyline (present vs. absent) and the degree of interactivity with learning content (high vs. low) on learning and retention. The author created a synthetic learning environment that included a hybrid of games and simulations to teach African American history topics on slavery and the Underground Railroad to college students. The storyline design element was manipulated by presenting a story either through a narrative (storyline present) or a text-based list of facts (storyline absent). The degree of interactivity with the learning content was manipulated by presenting the events either through a synthetic learning environment (high interactivity) or through text only (low interactivity). The Story with Interactivity version was created using the COTS computer game Neverwinter Nights® and allowed students to interact with the characters and drive the plot development. The results revealed that students in the Storyline with Interactivity condition performed more poorly than the rest of the intervention groups; but their enjoyment was the highest among the four learning conditions. In addition, the presence of story resulted in weaker retention. The presence or absence of a storyline did not affect student performance when interactivity was low. However, when interactivity was high, the combination of a storyline with high interactivity negatively affected student learning. In sum, the degree of interactivity with learning content did not have any effect on learning, while adding a storyline game feature negatively affected student performance. In terms of enjoyment, both storyline and interactivity with learning content game design features had a positive effect on student enjoyment.

Koenig (2008) conducted a pre-/post-test experimental study with college students (age $M = 23$) to examine the effects of a contextual game narrative (present vs. absent) on student learning of electrical circuits, narrative awareness, and the attitude toward the learning environment. In order to conduct the study, a game was developed using Visual Basic.Net and the TrueVision3D game engine. Students explored the game environment through an avatar that visited different rooms, moved objects, and operated electrical equipment. The narrative version of the game included a pre-game video-based story that students watched prior to playing the game. The goal of this pre-game story was to immerse a player into the game world and describe the character with which the player needed to identify. The in-game narrative guided a student to complete specific tasks. Players in the narrative game version interacted with other characters, documents, objects, and the game environment. The non-narrative version did not include any pre- or in-game story. There were no characters or story that guided the players. The game environment and learning content were the same, however, as found in the narrative version. Non-significant differences in student post-test performance appeared between the narrative and non-narrative interventions. However, students in the narrative version completed in-game learning objectives with significantly fewer attempts than did those in the non-narrative version. According to the authors, this finding might indicate that narrative facilitated a greater metacognitive awareness. In addition, students in the narrative intervention reported significantly higher enjoyment of the game than those in the non-narrative group. Non-significant differences in perceived cognitive load between the interventions were also revealed. To evaluate participant awareness of the game narrative, students were asked to describe in writing their impressions of the story they experienced during the game play. The narrative group participants reported a significantly higher level of awareness.

More recently, Spires et al. (2010) conducted a pre-/post-test experimental study that investigated the effects of different types of narratives on microbiology learning and engagement for eighth-grade students (age $M = 13.26$) when using a narrative-centered

learning environment called *Cristal Island*, implemented with Valve Software's Source™ engine, the 3D game platform for Half-Life 2. The virtual world of Cristal Island creates a setting for a recently discovered volcanic island where the player then solved a science mystery. The gaming environment allowed the player to explore the virtual world of the island, interact with game characters, operate lab equipment, manipulate objects, collect data, and form and test hypotheses. All interactions in the Cristal Island virtual world were fully text-based and menu-based. Three versions of a single learning environment were developed to test the instructional benefits of storyline design: Crystal Island Narrative, Crystal Island Narrative-Light, and Content Control. All versions shared the same learning content. Both the Narrative and Narrative-Light versions were developed using the Crystal Island game platform and then enhanced with a storyline. The Narrative-Light approach included fewer details than the Narrative intervention. The Content Control group received a PowerPoint presentation that did not include the storyline. The results indicated that including the narratives (full or light) significantly decreased learning; however, including a light narrative significantly increased student engagement levels. It is also important to mention that caution should be used when comparing Narrative or Narrative-Light versions with the Content Control/No Narrative condition. The Narrative or Narrative-Light condition featured the interactive Cristal Island gaming environment, while the Content Control condition used a text-based PowerPoint presentation. Thus, the Content Control condition differed from the other two conditions in not only the presence or absence of a storyline game feature, but also in overall gaming appeal. In sum, the authors suggested that the Narrative condition imposed an excessive cognitive load on students, which negatively affected their learning. However, since cognitive load was not measured in the study, future research is needed to verify how cognitive load may affect student performance in such storyline-enhanced learning environments.

Bittick and Chung (2011) conducted a pre-/post-test experimental study to evaluate learning outcomes and benefits of a narrative used in an educational game to teach mathematics. In the study, 177 students from grades 6–12 were randomly assigned to one of three versions of the game: (1) masculine narrative (focused on fighting); (2) feminine narrative (focused on the relationships between two sisters); and (3) a control (no narrative). The number of females and males in each intervention group were approximately balanced. Each narrative was presented via a series of images accompanied by text that popped up during game play. Participants helped the game character win over hazards by placing trampolines and dragging coils onto trampolines. Students that interacted with the masculine narrative showed significantly higher learning gains after interacting with the game than did those in the feminine narrative group. In addition, students in both narrative groups reported a significantly higher perception of flow than did those in the control group. The analysis of student math learning and motivation when matched with the gender of the game avatar revealed non-significant differences. No other significant differences on other learning or game engagement measures were found between the intervention groups. According to the authors, the results confirmed that narrative provides greater motivation for playing games for males than for females, because males are more interested in game play than females. However, the hypothesis that such increased perception of flow would result in increased learning outcomes was confirmed only for students in the masculine narrative.

The most recent empirical investigation into the instructional benefits of storyline-enhanced learning was conducted by Novak (2014a) (see also Novak et al. 2014). The goal of the study was to investigate instructional benefits of a storyline game design element on learning effectiveness, efficiency, and engagement, using an online instructional simulation

in an introductory statistics course for graduate students (age $M = 28$). In addition, the study examined the effects of a storyline on factual, conceptual, and application knowledge learning outcomes. A storyline was embedded into an instructional simulation that engaged students in problem-solving and data analysis in the context of basic statistics. Two different versions of the simulation that had the same instructional content but differed in the presence or absence of storyline were developed. The story-based intervention presented learners with the *Career Coach Simulation* where a student adopted the role of a career coach in a career-advising company. The student was guided to analyze various job opportunities for company clients by analyzing job-related aspects like income, employment sector, job stability, etc. The storyline was presented using both animations and audio-based dialogues conducted between the storyline characters. The results revealed that including a storyline in a simulation did not contribute to significant improvements in learning effectiveness or efficiency. The analysis of student performance scores for factual, conceptual, and application knowledge also did not reveal any significant differences between the interventions. However, learning gains for both intervention groups significantly improved from pre- to post-test, particularly in terms of application knowledge. Both intervention groups reported relatively high levels of engagement. Yet, contrary to the study hypothesis, significantly higher engagement levels were observed among students from the non-story than for the story-based group. In addition, students in the story-based intervention reported significantly lower interest toward the simulation, which could explain the unexpected findings for student engagement. According to the authors, adding a storyline could have distracted students from the instructional task and hindered their learning.

In conclusion, six of the seven experimental studies that manipulated a storyline game design element revealed either non-significant or lower learning gains associated with story-based instruction. To further analyze these findings, I included below a synthesis of learning and motivational/affective outcomes by storytelling approach and a synthesis of motivational/affective outcomes by learner age.

Learning and motivational/affective outcomes by storytelling approach

Six experimental studies with middle school and college students demonstrated that including a storyline either decreased or had no effect on learning and mixed effects on motivation and engagement (Bittick and Chung 2011; DeRouin-Jessen 2008; Greenwood-Ericksen 2008; Koenig 2008; Novak et al. 2014; Spires et al. 2010). In all of these studies, the learning environments used an interactive in- or out-of-game storytelling approach that required active involvement with the storyline events and/or characters. These findings suggest that this type of story demands more involvement with storyline events and probably increased working memory resources that may result in higher cognitive load, which then negatively affects learning (Sweller 1994). Interesting findings related to the effect(s) of the interaction between a storyline and other game design elements were also found. For instance, combining a storyline with highly interactive media significantly decreased learning gains; yet, interactive learning content without a storyline contributed to higher player enjoyment (Greenwood-Ericksen 2008).

By way of contrast, one experimental study with elementary school students who interacted with environmental stories showed positive learning gains (Parker and Lepper 1992). Another two studies that employed environmental storylines showed positive motivational/affective outcomes for elementary school students (Malone 1981; Parker and Lepper 1992). According to the authors, these stories were "virtually devoid of interest value. There are no

characters with whom students would identify, no meaningful goals, indeed no plots to be followed" (Parker and Lepper 1992, p. 632). Such environmental stories that arise from the 3-D game settings like graphics, visual and audio effects and do not include any plot or characters probably require less cognitive resources than interactive story-based learning that requires learners to respond to storyline events and relate to story characters.

Motivational/affective outcomes by learner age

Learner age is another moderator variable that may explain the storyline effects on learning and motivation. There is a continued decrease in school-age student motivation from 3rd to 9th grade (Harter 1981). It is relatively easy to keep younger students engaged in learning by providing them with small prizes or "party" points. This difference can possibly explain the positive learning gains revealed in the Parker and Lepper (1992) study using elementary school students and no or negative learning gains found in the rest of the experimental studies using secondary and college students.

Perceptual and cognitive outcomes

Four of the eleven studies (36 %) examined participants' cognitive (e.g., cognitive load) or perceptual outcomes (e.g., participants' experiences created by a story). A major challenge associated with the design of storyline-enhanced environments is the development of engaging stories and the evaluation of participants' experiences created by a story (Novak et al. 2014). Koenig (2008) examined student cognitive load associated with playing a video game for teaching the principles of electrical circuits as a possible factor explaining player satisfaction. Another three studies explored participant perceptions in non-educational games, but they were included in the literature review due to their relevance in terms of examining flow experiences through self-presence and sense of immersion aspects. Immersion in video games is defined as "the sensation of being in the game" and is considered one of the major motivations for people to play a game (Calleja 2011). Immersion "is not a stand-alone experience but the result from blending of a variety of experiential phenomena afforded by involving gameplay", which serve as a "prerequisite to the experience of higher-order cognitive processes… in much the same way that attention is a prerequisite of involvement" (Herrewijn et al. 2013, p. 1). Given the extensively acknowledged motivational appeal of stories, examining learner experiences of immersion in storyline-enhanced environments may offer valuable insights into the process of storyline-based learning. Presence is another theoretical construct that may be particularly important for both the design and the evaluation of entertainment media-based environments. According to Lee (2004), presence is "a psychological state in which the virtuality of experience is unnoticed" (p. 32). Examining the constructs of self-presence and sense of immersion in digital storyline-enhanced environments may offer practical guidelines for "making the learning content part of the flow experience" (Habgood et al. 2005, p. 492), which is considered as one of the biggest challenges associated with the design of effective and engaging educational games and game-like learning environments.

Park et al. (2010) examined the effects of pre-game stories (external storytelling) on player feelings of presence and the evaluation of a computer (non-educational) game with undergraduate students. The authors conducted two experimental studies that manipulated either a video-based or a text-based pre-game story (present vs. absent). Neither of these two studies showed any significant effect of a pre-game story on feelings of presence. However, both studies revealed that participants exposed to a pre-game story evaluated that

game more positively than those who were exposed to the non-story intervention. These findings suggest there is merit in investigating the effects of pre-game stories in educational learning environments.

Herrewijn et al. (2013) investigated the effect of a story on the player experience of immersion in a non-educational game. The authors created two versions of a commercial single-player, action role-playing game using the game editor. One version had an elaborate narrative. The other version included a very limited narrative where players performed only simple mechanical tasks. Participants (age $M = 22.3$) were randomly assigned to one of these two interventions. The results indicated that participants in the elaborate story version reported a significantly higher narrative involvement. However, non-significant differences between the two interventions were found for other dimensions of player involvement, namely, kinesthetic, ludic, affective, negative affect, positive affect, challenge, tension, pleasure, arousal, dominance, or immersion.

Both Park et al. (2010) and Herrewijn et al. (2013) provided interesting insights into the theoretical constructs and instruments used to assess the user experiences created by a game. Their findings suggest that sense of presence and immersion are important aspects associated with story-driven games. Examining these experiences in story-based learning environments can help further evaluate the effects of a storyline design element on student motivation and academic performance.

Discussion

There are many challenges involved in exploring the effects of game design elements, and storyline in particular on learning. To examine the relationships between a game design element and learning fully, it is important to understand how each particular game design feature affects specific learning outcomes and/or benefits. This focus means that game design elements need to be studied in isolation. It is a very difficult task since COTS games usually incorporate multiple game design elements and do not allow for code modifications. Developing digital learning environments that seamlessly integrate a storyline in the learning content is a very time- and effort-consuming endeavor. This fact can probably explain the paucity of empirical research currently linking storyline with human learning.

A closer examination of various types of storyline and fantasy elements used in the gathered studies reveals that storylines represent quite a broad concept. Stories can serve a major role in the learning process by guiding the presentation of the learning materials via audio-based, text-based, or interactive multi-media based narratives or just offer an idea about the location or settings where the learning activity takes place. Moreover, the researchers were concerned with the story delivery medium (e.g., graphics, music, and interactions with the gaming environment, text, or illustrations) and the amount of details that a story provided and how it might affect learning. Apparently, a deeper investigation of the effects of storylines in digital learning environments should be attempted.

Given the theoretical framework of the memory research underlying story-based instructional approach, it was surprising to find only two studies that evaluated the effects of a storyline on retention and only one study that examined student cognitive load associated with story-based learning. Storyline-enhanced learning poses higher working memory demands for learners who need to comprehend the information presented using various visual, audio, or/and linguistic inputs and consequently extract the relevant details while suppressing irrelevant to the learning task information (Stevens and Bavelier 2012). These

methodological issues require researcher attention and should be clearly taken into account when designing future studies on story-based instruction.

Future research should also investigate the process of digital story-based learning. According to Kinzer's et al. (2011) examination of three narrative presentation formats (within a popular video game, as a comic book, and as a book) and their effects on middle-school students' reading comprehension and motivation to read, the narrative length and presentation format can significantly affect the process of storyline-enhanced learning. After the first 10 min, there were non-significant differences in student interest toward the story between the three groups. However, at the 45-min mark, the book group showed the most interest and the game group reported the least. Moreover, the book group outperformed the comic group and the game group on literal comprehension scores. The perceived task difficulty was higher among the game group students than the other two groups. These findings illustrate the complexity of digital story-based learning, which needs to be further explored in the future.

The topic of the story might affect student performance and motivation as well. A recent study that investigated how a problem topic affects high school students' mathematics story problem solving revealed that topics involving familiar contexts like family and school as opposed to more abstract physics or financial contexts were associated with higher learning performance (Walkington et al. 2014). Although the study did not concern digital storyline-enhanced learning, its findings might be relevant for designing digital story-based learning environments, as familiar contexts with clear meaning allow students to more easily relate to the story and construct situation model representing the story events and actions (Nathan et al. 1992).

In sum, this literature review is an important step forward for a systematic review of empirical research that links game design elements to different learning outcomes and benefits. Literature reviews similar to this one that was undertaken can provide clearer practical guidance on how to develop effective game-like learning environments and a richer understanding of the challenges associated with the design of these learning environments for different audiences. Moreover, examining various types of storylines and their effects on academic achievement can further advance the development of learning and teaching theories overall.

There are several limitations associated with the literature review findings. The literature review included several unpublished studies like conference proceedings and dissertations that might not be peer reviewed. In addition, factors such as the difficulty of the learning task, the type of the digital learning environment, and the storyline length, appeal, and context were not explored as potential moderator variables of the storyline effects on learning and motivation. As the research on digital story-based learning develops, employing meta-analytical methods should provide more accurate findings with regard to the relative effectiveness of a story-based approach as compared to a non-story-based method.

Implications for designing storyline-enhanced learning environments and further related research

What can be learned from this literature review? Although a very limited number of relevant studies have been undertaken to date, certain themes related to the design of storyline-enhanced learning environments have already emerged. Stripping down a storyline design element from storyline-enhanced learning environments produced either non-significant or better learning in most of the studies. Contrary to all expectations, students

who interacted with narrative learning environments did not always report higher motivation or engagement than those who interacted with non-narrative ones. Nevertheless, researchers do believe that an appealing story has a strong motivational effect, while non-appealing stories can detrimentally affect student motivation. Moreover, gender and ethnicity can affect student preferences for these narratives (Bittick and Chung 2011; Moreno and Mayer 2005). Possible solution(s) to leverage motivational and engagement challenges effectively could include (1) evaluating student experiences created by a story; (2) assessing learner cognitive and working memory resources associated with story-based learning to ensure that storylines do not pose extraneous cognitive load or distract learners from the instructional task at hand; (3) employing more adaptive learning environment design (Conati and Maclaren 2009); and (4) using mathematical models to diagnose motivational, volitional, and performance issues and correct them (Novak 2014b). In addition, embedding pre-game stories might promote student engagement with that story, if a student is expected to identify with an avatar or storyline characters. Exploring the effects of environmental stories, as opposed to interactive ones that require deeper engagement with the narrative, should also be explored.

In spite of these perhaps discouraging findings, the researchers argue that narrative-based learning environments can improve student confidence, self-reliance, and creativity (Walkington et al. 2012). In addition, such stories can provide contextual anchoring and facilitate better knowledge construction and information organization (Bransford et al. 1990). Future research should explore these theoretical constructs, as they relate specifically to story-based learning.

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